STANDARD OPERATING PROCEDURE

FOR

ROUTINE OPERATION OF THE ANDERSEN INSTRUMENTS AETHALOMETER™ FOR MEASUREMENT OF BLACK CARBON CONCENTRATIONS IN CRPAQS

STI-999214

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1. SCOPE & APPLICABILITY

The AE-16 Aethalometer™ continuously collects an aerosol sample on a quartz-fiber filter and measures the amount of optically absorbing material collected throughout a 5 minute sample segment. The filter area and sample air flow rate are then used to calculate the ambient concentration of absorbing material. Since black carbon (BC) is the dominant optically absorbing material in the submicron size range, this measurement is interpreted as the mass of BC according to calibrations based on intercomparison with elemental carbon concentrations determined by the chemical analysis of filter samples.

This standard operating procedure is intended to:

- provide a basic understanding of the principles behind the Aethalometer light absorption measurement and the calculation method used to determine black carbon (BC) concentrations
- describe the routine procedure for instrument set-up, operation, documentation, auditing, and takedown
- detail the concerns and procedures that will insure valid light absorption measurements.

This SOP assumes that the field technician has read the Aethalometer operation manual supplied by McGee Scientific (1998).

2. SUMMARY OF METHOD

The Aethalometer provides a real time measurement of light absorption by particles. The instrument internally translates the measurement to ambient (BC) concentrations using the operational definitions for black carbon provided in the user manual. The Aethalometer measures the attenuation of light transmitted through a quartz-fiber filter and a supporting stainless steel mesh during the continuous collection of an aerosol sample on the filter. The rate of accumulation of BC is proportional to both the BC concentration in the ambient air and to the sample air flow rate. An internal mass flow meter monitors the sample flow rate. The sample air flows through a 0.5 cm^2 area of the quartz-fiber filter tape. The instrument measures the transmitted light intensities through both the 'sensing' portion of the filter (mentioned above) and an unexposed or 'reference' portion of the filter. The reference measurement is made to correct for fluctuations in the intensity of the light source. The signal (sensing) and reference measurements are made by a high intensity light emitting diode (LED) lamp at a wavelength of 880 nm and a pair of matched photodiodes. Measurements of the reference and sensing detector outputs are also made with the LED off to determine the zero offset (dark response) correction for the signals. All optical signals from the diodes are converted to voltages and digitized. A ratio is taken of the zero offset corrected signal and reference voltages. This ratio is converted to an optical attenuation value that is proportional to the increment of aerosol black carbon collected on the filter during each measurement cycle.

Measurement of BC concentrations taken by the Aethalometer have been compared to various other measurement techniques. The results of these analyses can be found in the references.

3. DEFINITIONS

The acronyms used in this SOP are as follows:

- BC – Black carbon
- BP – Barometric pressure
- COM port – Serial communications port on a computer
- ID – Inner diameter (tubing)
- LED – Light emitting diode
- LPM – Liters per minute
- OD – Outer diameter (tubing)
- SCC – Sharp cut cyclone
- ug/m^3 – Micrograms per cubic meter

4. HEALTH & SAFETY WARNINGS

The Aethalometer is not inherently "safe". It is not explosion-proof, and it is not constructed to be used in explosive or flammable environments. Although it does not have any mechanical-electrical contacts that might create sparks, it is not intended to be used in situations where it might cause an explosion or fire.

5. CAUTIONS

Installation

Please see section 4.7 titled 'Installation Requirements' in the Aethalometer user manual for a complete discussion of the following items.

- It is strongly recommended that the instrument NOT be placed in the direct flow of a heater, vent, or air-conditioner that may cycle on and off.
- The instrument should not be placed in an environment where the ambient temperature may exceed 100°F (40°C), nor where high relative humidity may lead to condensation.
- The instrument should not be installed in a location that may receive direct sunlight.
- The length of the inlet tubing should be minimized.

- A static-dissipating tubing should be used for the sampling inlet if the aerosol is highly charged.

Routine Operation:

- The outer panel door should remain shut during routine operation.
- If outer panel door is opened during the measurement cycle (required for certain aspects of operation) make sure that the instrument is not subject to direct sunlight.
- Do not touch the quartz-filter tape during the measurement cycle.
- The Aethalometer is normally operated with web-reinforced quartz fiber filter tape. Do not use a different type of filter tape without first consulting Magee Scientific. See section 4.8 titled 'Filter Tape' in the Aethalometer user manual for a more detailed discussion.

6. INTERFERENCES

The Aethalometer measurement process involves the mechanical transfer of a quartz-fiber filter across sensitive electronic optical sensors to measure light attenuation. Each of these actions as well as the installation and handling of the quartz-fiber filters are subject to potential problems from:

Careless handling of samples:

Improper cleaning of the stainless steel filter support screen between filter changes may lead to contamination of samples from previous measurements or from the cleaning process itself. The cleaning procedures described in this SOP must be followed diligently to avoid contamination problems. Despite the fact that the operator may be working within a dusty environment, every effort must be made to keep the instrument clean.

Stray light:

The light measured by the detector should be only that light generated by the internal lamp and transmitted through the filter tape. Light entering the detector by other routes will not be attenuated by the aerosol deposit and will bias the measurement. The optical head and photodetectors are protected from ambient light by the outer, temperature controlled, cover plate. However, if direct sunlight is not fully eliminated from the optical sensing area the measurement may be adversely effected. As a precaution, the instrument should not be in direct sunlight and the outer panel door should remain closed during operation.

The following interferences can be thought of as 'theoretical interferences'. They can not be minimized by the operating procedure or by a single instrument calibration. However, absolute calibration methods for the Aethalometer have been developed and are being applied, Hans Moosmuller et al. (1998). An absolute calibration of the Aethalometer involves comparing the

absorption properties of an aerosol sample collected on the quartz-fiber filter by the Aethalometer to the aerosol absorption measured under ambient conditions.

Modification of Particle Absorption by Filter Collection:

It is likely that some ambient particles have light absorption cross sections that are larger than the geometrical particle cross section. Collecting (and close packing) these particles may decrease the particle light absorption. In addition, the absorption cross section of aerosol particles may vary with the refractive index of their surroundings.

Modification of the Optical Properties of the Filter:

Particles collected on the surface of the fibers that form the filter can alter the internal reflection of light in the filter medium. This can alter the light absorption due the filter for only the sensing portion of the filter, and may thus bias the measurement.

7. PERSONNEL QUALIFICATIONS

All personnel are to be trained in the use and handling of applicable air quality monitoring instruments. All personnel have been introduced to the methodology behind air quality measurements and the goals of this monitoring study.

8. APPARATUS & MATERIALS

The instrument should be operated in an environment that is not subject to dramatic or abrupt temperature or relative humidity changes. The instrument should be placed in an environment that does not exceed 100°F (40°C) nor where high relative humidity may lead to condensation.

The materials needed for Aethalometer setup, routine operation, auditing, and takedown are as follows:

ITEM	COMPONENT	MANUFACTURER	S/N	#
3/4” PVC union	AETH			1 ea.
3/4” Schedule 40 PVC	AETH			10-15’
2” PVC cap w/ insect screen &	AETH			1
3/4" PVC	AETH			10-15'
3/8” OD aluminum tubing	AETH			25'
4" ABS cap	AETH			1
4” < 45' union, ABS	AETH			1 ea.
4” ABS	AETH			10-15'
Aethalometer	AETH	Andersen Instruments		1
Cyclone to tubing adapter	AETH			1
Extension cords, 25 '	AETH			2
Fitting for pump inlet	AETH	American Couplings	N 1020404 C	1
Instrument manual	AETH			1
Laptop (remote sites) or CRPAQS DAS	AETH			1
PM2.5 cyclone	AETH	Met One	8670	1

Pump	AETH	Gast	DOA-V191-AA	1
Plywood	AETH			1 sheet
Quick in-line connector for pump, barbed, _" ID	AETH	Swagelock		1
Rack/table/shelving to support 75 lbs.	AETH			1
Roof flange, 1 & 1/16" ID	AETH			1 ea.
Roof flange, 3/8" ID	AETH			1 ea.
RS232 cables/adapters	AETH			25'
Surge protector strip	AETH			1
Tripod	AETH			1 ea.
Vacuum grease	AETH			1 tube
Vinyl tubing, Reinforced 3/8" OD x _" ID	AETH			25'
****items needed for initial check**				
AETH task sheets	AETH calibration/setup tests			5 ea.
Barometer	AETH calibration/setup tests			1
BIOS, 1-40 LPM and assorted tubing	AETH calibration/setup tests			1
Calculator	AETH calibration/setup tests			1
Instrument manual	AETH calibration/setup tests			1
Laptop (remote sites) or CRPAQS DAS	AETH calibration/setup tests			1
Optical test-strip	AETH calibration/setup tests		Instrument specific	1
RS232 cables/adapters	AETH calibration/setup tests			
STI SOP	AETH calibration/setup tests			1
Thermometer	AETH calibration/setup tests			1
Timepiece set to DAS	AETH calibration/setup tests			1
Zero-air filter and tubing	AETH calibration/setup tests	Schleicher & Schull	#FP-050	1
****items to leave at site**				
3.5", 1.44 Mb diskettes	AETH consumables			2 ea.
Quartz-filter tape	AETH consumables	Pall Corporation	Q250F	2 ea.
Field Log book	AETH consumables			1
Tools needed:				
Rover toolbox, and:				
assorted cable ties				
assorted screws, Philips, wood 1/2 to 1-1/2 "				
assorted sockets				
assorted various nuts, bolts, washers				
Distilled water				
Drill, assorted bits				
Ethanol				
hacksaw				
Hole saw, 4 " or 1-1/4"				
Kem wipes				
level				
Packing tape				
pipe cutter				
plumbers tape				
Power cords				
Sawsall w/ blades				
Scissors				
silicone and gun				
Stapler w/staples				
Swabs				
Teflon tape, 1 roll				
Vinyl gloves, non-powdered				
voltmeter				

9. SITE AND EQUIPMENT PREPARATION

9.1 OFF-SITE / PRE-DEPLOYMENT EQUIPMENT SET-UP AND ACCEPTANCE TESTING

The Aethalometers are set up as outlined in Section 9, Unpacking and Setting Up the Instrument, of the user's manual (McGee Scientific, 1998). The external vacuum pump used for this study is to be connected to the external vacuum pump port on the back of the Aethalometer using $^{3}/_{8}$'' OD tubing. Select a 6.9 LPM flow on the flow control dial at the instrument back panel. See figures for an example of data output (Figure 1), schematic of measurement components (Figure 2), a flow diagram (Figure 3), or a schematic for the sharp cut cyclone (Figure 4).

The following tests are performed upon initial setup. **Record each of the measurements/results on Task 2 worksheets (note, two worksheets for Task 2).**

- The automated 'self test' function, outlined in the user manual's Software Operating Instructions section on page 55, is used to ensure that the instrument is functioning in accordance with manufacture specifications (McGee Scientific, 1998). The self-test runs diagnostic checks on the LED lamp, air flow, user interface panel screen, COM port functionality, and the automatic tape advance mechanisms.
- The optical test, outlined on page 59 of the same user manual, is performed to check the operation of the photodetectors. The interpretation and follow up procedures for the optical test results can be found on page 84, section 16.1, Optical Test Strip Algorithm, of the manual. If the optical test produces results that fall outside of the acceptable range ("Balance" or "Ratio" = 0.9 to 1.1 as outlined in section 16.1), contact the field manager or measurement expert.
- The internal mass flow meter is audited using the following procedure.

  a: Record the primary flow standard serial number and make.

  b: Record the current ambient conditions

  Record the current temperature and pressure using an external thermometer and barometer by placing both in a shaded area. Convert the measurements to K and mb.

  T (K) = T (C) + 273.15
  P (mb) = P (inHg) x 33.87 = P (mmHg) x 1.33

  c: Calculate the Ratio of STP to ambient conditions

  Use the STP conditions for the Aethalometer mass flow meter to determine the ratio between STP and the current temperature and pressure. STP for the Andersen Instruments Aethalometer is 293K and 1017 mb.

  Ratio of STP to ambient conditions = 293.15K x P (mb) / T (K) / 1017 (mb)

d: Record the time when the audit was started

e: Record several instrument flowrates (as seen on the instrument display)

Flow with cyclone – Record the instrument flow before attaching the BIOS.

Flow with BIOS attached – Remove the cyclone rain-hat and attach a tight-fitting BIOS hose to the cyclone inlet. Place the BIOS on a horizontal surface level with the top of the inlet, making sure that the BIOS hose does not crimp. You can use a ladder. Record the instrument flow after this has been done.

f: Record several BIOS flowrates (as seen on the BIOS display)

Adjust the valve on the audit adapter to allow air to flow to the instrument. Press and hold the STOP/RESET key on the BIOS until the BIOS screen shows:

```
Flow> L              OFF
      Average>       L              #
             Number in Average   ^
```

Press and hold the READ/AUTO key on the BIOS until you can hear the flow cell moving up and down. Allow the BIOS to count through several 1-10 sequences. When value3 reaches "10" again, write down value2 on the flow audit worksheet, where value1 is the current flow rate (LPM), value2 is the current average flow rate (LPM), and value3 is the current measurement number (out of 10) used to calculate value2.

```
Flow>                value1
Average>     value2          value3
      Number in Average   ^
```

Repeat this for 9 more cycles and fill out the worksheet. Reset the BIOS. Remove the cyclone and check the cyclone o-rings for cracking and wear. Replace as needed. Apply a new thin layer of high vacuum grease to the cyclone orings, and reattach the cyclone.

g: Record the time when the instrument was returned online.

h: Compare Aethalometer to BIOS

Average BIOS flow = Sum of the 10 BIOS readings / 10
Average adjusted BIOS flow = Average BIOS flow x Ratio of STP to ambient
Delta = Average adjusted BIOS flow - Instrument flow with BIOS attached
% Difference = (Delta / Average adjusted BIOS flow) x 100

i: If the percent difference exceeds 10 percent, advance the filter tape once or twice by holding the “Advance Tape” switch down for about 30 seconds. Re-audit the flow meter with the new filter tape position.

j: A percent difference greater than 10 % warrants re-calibration of the flow meter, see section 14.4 of this SOP.

k: Comments

NOTE: If the percent difference exceeds 10 percent advance the filter tape once or twice by holding the "Advance Tape" switch down for about 30 seconds. Re-audit the flow meter at the new filter tape position.

- A dynamic zero check is performed on the instrument. Attach a large-area, low-resistance filter on the Aethalometer inlet so that it samples particle free air. The data should fall to 0 ± noise (0.4 $\mu g/m^3$) after a few timebase periods (5 minutes).

9.2 ON-SITE EQUIPMENT INSTALLATION

The Aethalometer should be installed at the site taking into account the installation cautions listed above. A sample air flow rate of 6.9 LPM will be used so the sharp cut cyclone (SCC), which prevents coarse particles from entering the sampling manifold, will have a 2.5 µm cutpoint. The SCC is to be installed at the ambient inlet using a set screw. The flow rate is selected by the flow control dial on the instrument back panel. The instruments are shipped with the quartz filters preloaded. Open the outer panel door and make sure that the filter is in place. If no filter is loaded follow the instructions of section 10, Filter Tape Installation, starting page 44.

Section 9 of the user's manual outlines the instrument set up procedures (McGee Scientific, 1999). Make sure to follow these instructions through the software set-up procedures, page 42. The instructions for how to check (and change) system settings can be found within the Software Operating Instructions section of the manual. This section should be read in its entirety.

The following parameter settings are recommended. Do not deviate from these settings unless instructed to do so by the field manager. All system settings that pertain to the CRPAQS study measurement scheme or that can effect the measurement are outlined below. The following settings can be accessed within the "Change Setting" function.

<u>Date and time should be set to Pacific Standard Time:</u>

- Within the menu item 'Change Sys. Settings' go into the 'Date & Time' setting.
- The screen will show time (hh:mm) and date (dd-mm-yy). There is a flashing cursor over the hour.
- Use the right and left arrows to position the cursor correctly and use the up and down arrows to change the values under the cursor.
- Set the instrument clock AHEAD one minute from the current time read by the external clock. For example, if the external clock reads 17:06:23, set the instrument clock to 17:07.

- When the seconds get to 55 on the external clock, press enter and go to the next menu item.
- Press ESC. This will terminate the 'Change Settings' process. You will get a screen 'Save Settings ?' and the prompt is already set to YES.
- Press enter when external clock reads 58 seconds past the minute. This activates the 'YES' of the 'Save Settings'. The screen will say 'Writing settings' and then revert back to main menu.

The following settings should be entered:

- The time base period should be set to **5 minutes**.
- The tape saver option should be turned **OFF**.
- The analog output will not be used for data acquisition. The port can thus be set to **ALARM MODE** with the alarm set **OFF**.
- The warm up and wait option should be set to **ON** for routine operation. It can temporarily be set to OFF for set-up and testing procedures. The warm up period is the period of time the instrument takes before resuming measurements once the instrument is allowed to go back into the operate mode.
- The communications port will be used for data acquisition. Therefore, the communication mode should be set to **DATALINE**
- The COM settings are: Baud rate – **9600**, Data bits – **8**, Stop bit – **1**, Parity – **none**
- The overwrite old data option should be set to **ON**. This option should be irrelevant since the data diskettes will be changed on a monthly basis.
- The 'Filter Change At' value should be set to zero. A zero setting allows the instrument to advance the tape at 75% of optical saturation rather than on a timed cycle.
- The security code should be set at the default value of 111. If the security code differs for any reason, it should be set back to the default value immediately. This precaution is taken to ensure that each instrument, independent of the site or operator, function in a similar and project wide manner.
- The date format should be set to U.S..
- BC display unit should be set to ug/m3.
- The data format should be set to the expanded option.
- The instrument serial number is preset. It should match the serial number on the back of the instrument and on the optical test stripe provided with the instrument. Do not change this setting.
- The 'Spots per Advance' option should be set to 2.

9.3 ON-SITE ACCEPTANCE TESTING

Once the Aethalometer is installed at the site and system settings have been checked, the operator should perform the following diagnostic tests as discussed above in subsection 9.1, "Off-site / pre-deployment equipment set-up and acceptance testing":

- The automated self test function.
- The optical test procedure.
- Audit the internal mass flow meter.
- The dynamic zero test.

9.4 ON-SITE CONNECTION OF EQUIPMENT TO DATA ACQUISITION SYSTEM

- The Aethalometer is to be connected to the data acquisition system via the RS232 COM port located at the back of the instrument. Connection is to be made using a null modem cable or a null modem connector and standard cable in series.

10. INSTRUMENT OR METHOD CALIBRATION

If the on-site equipment acceptance test procedures are followed as outlined above and the results are acceptable than the instrument needs no further calibration. The calibration procedures for the flow meter are outlined in section 14, Flow meter Response Re-Calibration, of the user's manual. This section will refer you to page 56 of the Software Operating Instructions section, Calibrate Flow meter.

11. SAMPLE COLLECTION

Care should be taken not to contaminate the unused quartz-fiber filter tape. This entails the use of vinyl gloves when handling the filter and making sure that dirt, water, or grease does to come in contact with the unused filter at any time.

12. HANDLING & PRESERVATION OF SAMPLES

Used filter samples may be discarded unless otherwise directed by the field manager.

13. SAMPLE PREPARATION

Spare quartz fiber filter tapes should be stored in a cool and dry location.

14. ROUTINE OPERATION / PREVENTIVE MAINTENANCE & REPAIRS

Once the instrument has been set up and tested, it is ready to begin taking measurements. The tests or checks outlined below should be executed on a weekly and monthly basis respectively. These tasks are summarized in a Quick Reference Guide. This guide and detailed steps to perform each task are presented at the end of this document.

14.1 WEEKLY TASKS (TO BE RECORDED ON TASK 1 WORKSHEET)

Check the percentage of remaining filter tape:

- The amount of tape used per week will vary from site to site. The percentage of filter used in the first full week of routine operation should be recorded and used as an indicator for the minimum percentage of tape needed for one week of sampling at this site. The filter tape should be changed when the percentage of remaining tape nears this estimated value required for one week of sampling.

Check diskette capacity:

- Diskettes should be archived monthly at a minimum. However, the diskette should be changed prior to having 2 days left (2d) regardless of the archiving scheme.

Check that flow rate is consistent (within 5%) from week to week:

- Flows are expected to vary within the reasonable tolerance of the mass flow meter. However, if the flows deviate by more than 5% from week to week, the flow system should be examined.

Review message files:

- The message files contain warnings that the Aethalometer has issued in the last week of sampling.
- These files (named Mfmmddyy.txt) are stored on an internal diskette and should be read. Record any errors in the Task 1 worksheet comment section.

Examine raw data for instrument issues:

The raw data should be examined for possible instrument drift, unrealistic variance in consecutive values, or values outside of instrument or expected ranges. The suggested data review techniques are listed within the Task 1 description of this SOP.

14.2 MONTHLY MAINTENANCE

- Check the inlet orifice. (15 min)
- Maintain the instrument cyclone. (15 min)
- Maintain the vacuum pump. (10 min)
- Change the data diskette. (5 min)

14.3 MONTHLY CHECKS (TO BE RECORDED ON TASK 2 / 3 WORKSHEET)

Perform the On-site acceptance Testing procedures:

- The automated self test function. (5 minutes)
- The optical test procedure. (15 minutes)
- An audit of the internal mass flow meter at the cyclone. (30 minutes)
- A dynamic zero test. (30 minutes)

14.4 RECALIBRATE FLOW METER:

- This is ONLY to be performed when the site operator is convinced that the internal mass flow meter is operating outside of a 10 percent difference from an external low impedance calibrated flow meter.
- This task requires approval by Siana Alcorn or Beth Wittig.

14.5 AS NEEDED/BIMONTHLY TASKS

- Pump maintenance.
- Replacement of the filter tape.
- Repairs to instrument: Any repairs required for the instrument should be performed by Andersen Instruments or Magee Scientific.

15. TROUBLESHOOTING

The Aethalometer issues warning messages in both the message files and the front panel display. The message files are to be reviewed on a weekly basis. Error messages issued to the front panel display are usually of a more severe type. The most common errors are associated with the flow rate. Check the sampling the inlet and lines from the vacuum pump for bends, punctures, or tares. The pump itself should also be checked (both the diaphragm and filters).

An Original Program disk is provided with instrument equipment. This disk can be recreated by the procedure given in Appendix A downloaded from the Magee Scientific web site, www.mageesci.com.

16. DATA ACQUISITION, CALCULATIONS & DATA REDUCTION

The data are written to the internal diskette every time base. One data file is created per day. The data files are named Bc*yymmdd*.csv and are written on comma separated format. The type of data provided is shown in **Figure 1**. Data reduction and validation will be performed at STI.

17. COMPUTER HARDWARE & SOFTWARE

The following hardware is needed to acquire digital data from the Aethalometer:

- Communications Connector: 9-pin D-sub, i.e., standard pins for the IBM-PC COM functions.
- A null modem serial cable, or a null modem connector and standard serial cable in series, will be required to connect the Aethalometer to the data logger.

18. DATA MANAGEMENT & RECORDS MANAGEMENT

Maintain an instrument log book with the following entries:

- The date.
- All maintenance procedures applied to the instrument.
- Times at which the instrument was taken off and put back on line.
- Times at which the filter tape was changed.
- Records of anything unusual about the instrument, its operation, or the environment.
- Print-outs of the message files. These should be looked at on a weekly basis for possible instrument malfunction.

Maintain a chain of custody:

- All Worksheet and Audit Forms should be maintained chronologically in a ring binder, file cabinet, or other organizational device.
- Monthly data diskettes should be labeled with the Instrument Serial Number, and the Month and Year of data. Diskettes should be sent to Siana Alcorn or Steve Ludwig c/o Sonoma Technology Inc., 1360 Redwood Way, Suite C, Petaluma CA 94954-1169.

19. CONTACTS

The primary contact (measurement expert) for the Andersen Instruments Aethalometer is Siana Alcorn. She can be contacted by the following means:

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20. REFERENCES

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Date	Time	BC conc (ng/m3)	Flow LPM	Signal Zero	Signal	Reference Zero	Reference	Fraction	Attenuation
22-Oct-99	0:00	608	6.6	0.0217	0.7355	0.0216	3.6171	1	58.719
22-Oct-99	0:05	613	6.6	0.0217	0.7332	0.0216	3.6296	1	59.397
22-Oct-99	0:10	604	6.6	0.0217	0.727	0.0216	3.6224	1	60.065
22-Oct-99	0:15	609	6.6	0.0217	0.7214	0.0216	3.618	1	60.739
22-Oct-99	0:20	567	6.6	0.0217	0.7197	0.0216	3.6315	1	61.366
22-Oct-99	0:25	617	6.6	0.0217	0.7125	0.0216	3.6187	1	62.049
22-Oct-99	0:30	580	6.6	0.0217	0.7086	0.0216	3.6215	1	62.69
22-Oct-99	0:35	591	6.6	0.0217	0.7063	0.0216	3.6333	1	63.344
22-Oct-99	0:40	585	6.6	0.0217	0.6997	0.0216	3.6217	1	63.991
22-Oct-99	0:45	531	6.6	0.0217	0.6958	0.0216	3.622	1	64.578
22-Oct-99	0:50	595	6.6	0.0217	0.6938	0.0216	3.6348	1	65.235
22-Oct-99	0:55	585	6.6	0.0217	0.6881	0.0216	3.6272	1	65.883
22-Oct-99	1:00	512	6.6	0.0217	0.6833	0.0216	3.6218	1	66.449
22-Oct-99	1:05	619	6.6	0.0217	0.6814	0.0216	3.6361	1	67.132
22-Oct-99	1:10	596	6.6	0.0217	0.6772	0.0216	3.637	1	67.792
22-Oct-99	1:15	581	6.6	0.0217	0.6706	0.0216	3.6237	1	68.434
22-Oct-99	1:20	508	6.6	0.0217	0.668	0.0216	3.6293	1	68.995

Figure 1. Example of data output.

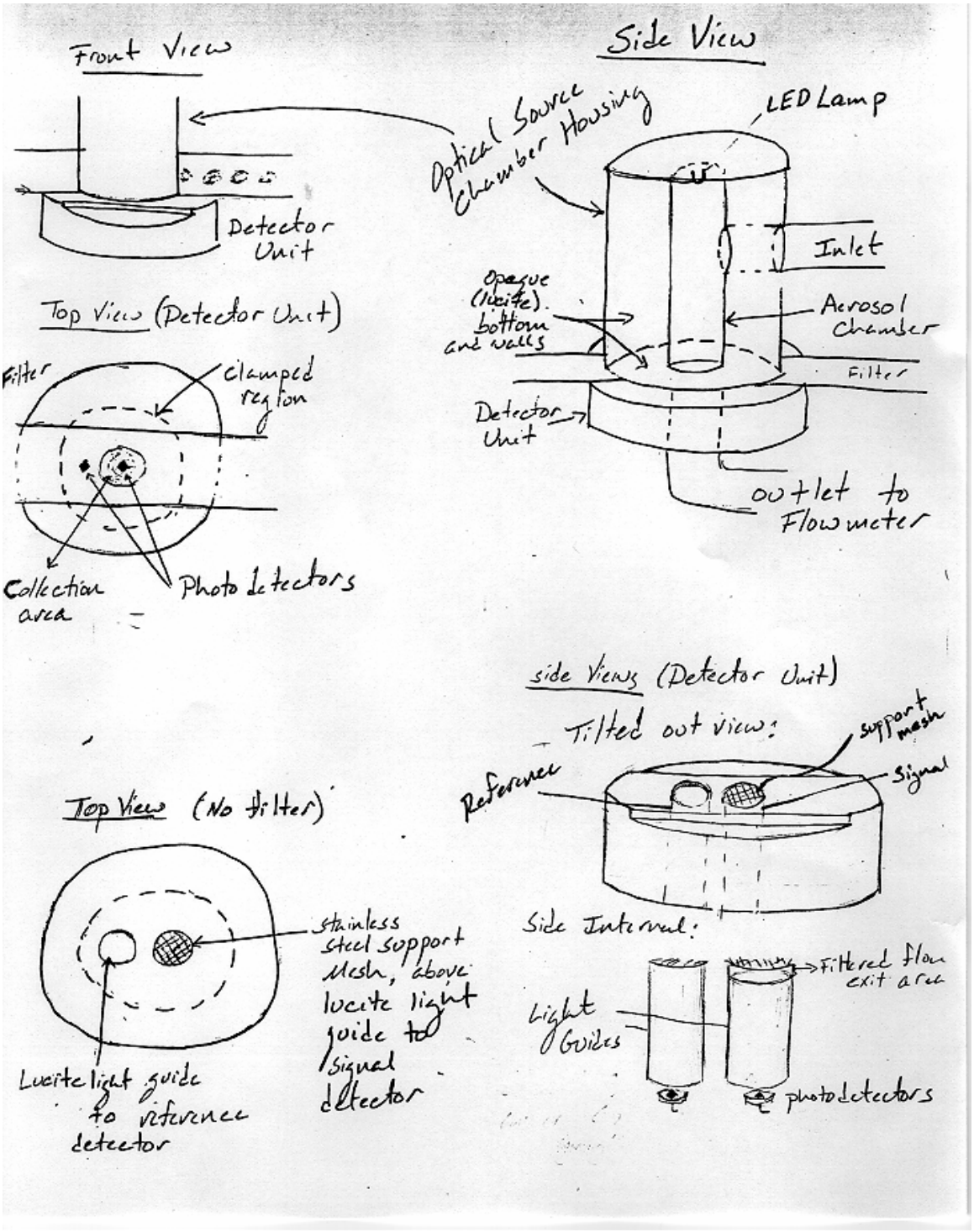


Figure 2. Schematic of Aethelometer measurement components. Diagram is not drawn to scale.

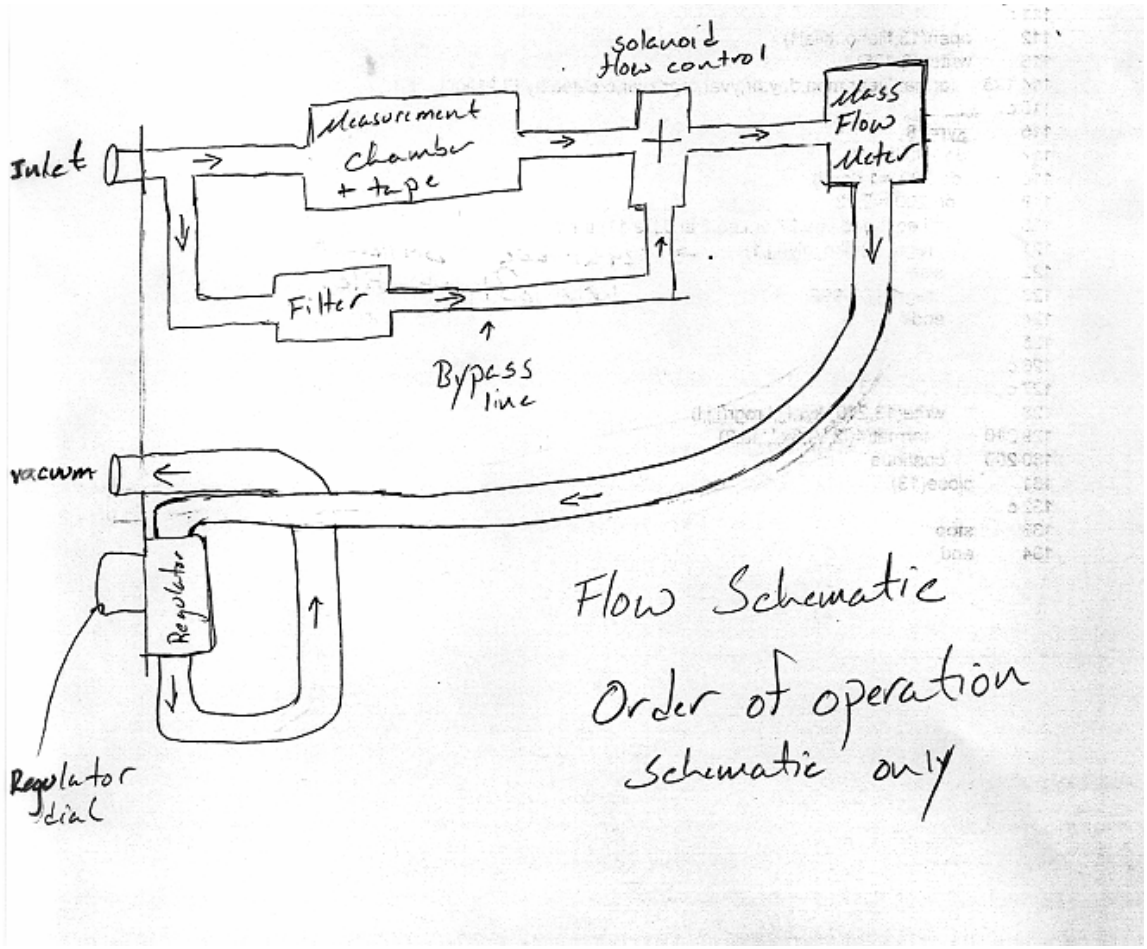


Figure 3. Aethelometer flow diagram. Diagram is not drawn to scale. Bends in the line and distances between components are not to be taken literally.

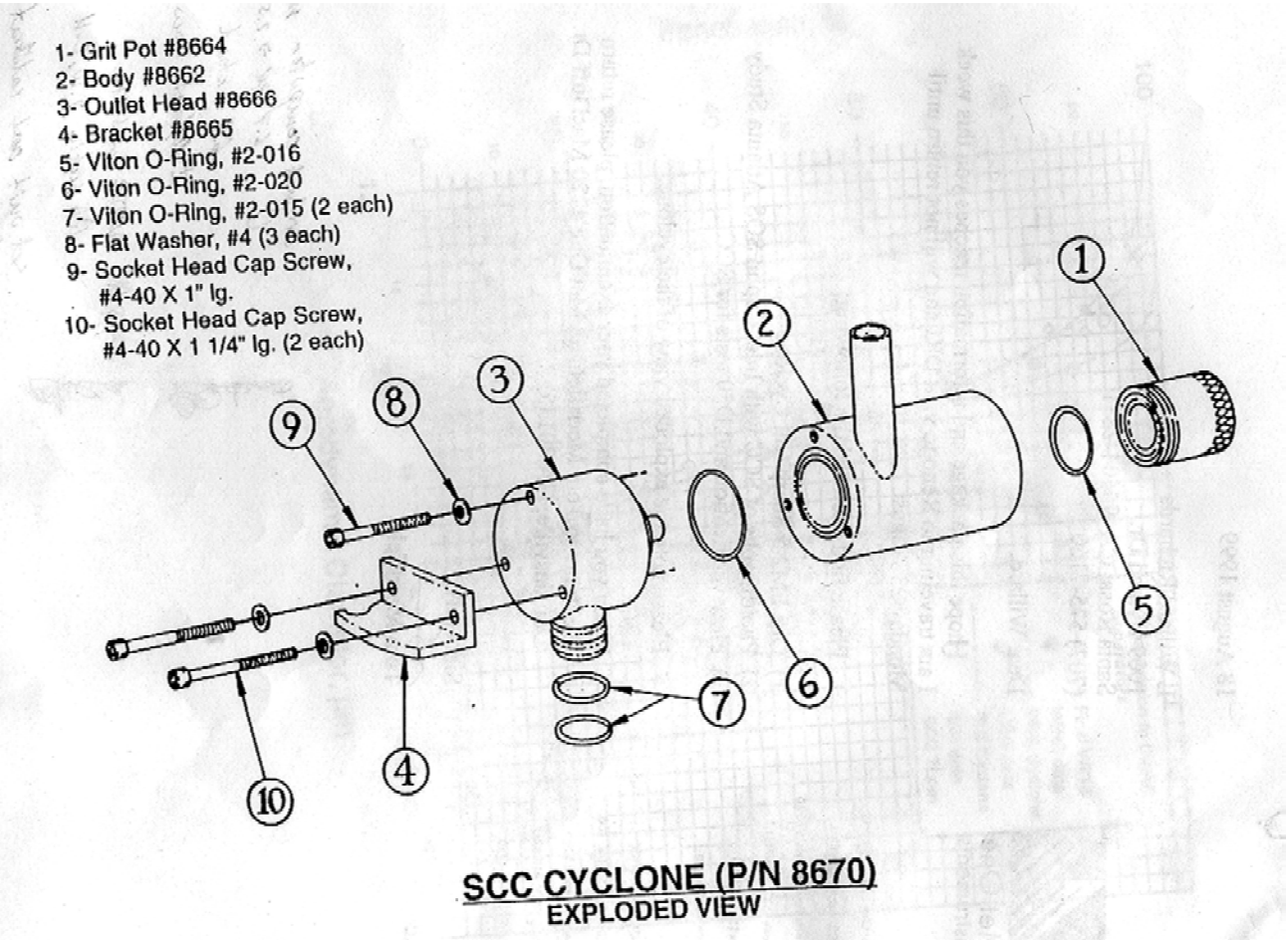


Figure 4. Manufacture's schematic of sharp cut cyclone.

Task Table 1: Andersen Instruments Aethalometer Quick Reference Sheet.

(Detailed procedures and troubleshooting for each task follow the Task Table 1 and are listed by task number. ME = measurement expert, FM = field manager)

Task		Performance statistic	Section of SOP or Manual		Frequency	Time	Work-sheet
			Additional task guidance	Additional troubleshooting guidance [1]			
1	**Weekly checks**						
	Check filter tape	No tears	Task 1	Check for obstructions along filter track.	Weekly	30-45 min	yes
		No overlapping or oddly shaped samples		Check for obstructions at the nozzle and optical chamber. Check to see that the "Spots Per Advance" setting = 2 in the "Change Settings" menu.			
		Proper spooling of filter tape		Check that the take up reel sensor is not stuck in the "taught" (left most) position. Call ME.			
	Check flow rate	6.9 LPM ± 10%		Check integrity of pump. Check for obstructions at cyclone, instrument inlet (back of instrument), and nozzle. Advance filter tape.			
	Check % tape remaining	> 10%		Load new filter tape.			
	Check disk remaining	> 10d		Load new disk, label used disk, and send to STI.			
	Record error messages	N/A		N/A			
2	**Monthly checks**						
	Self test	Check that all tests pass	Task 2, Manual 13.4	Call ME or FM.	Monthly	80 min 5 min	yes
	Optical test strip procedure	Balance = 1 ± 0.1	Task 2, Manual 13.7, 16.1	Strip should lay flat and flush against back of sensing region.		15 min	
	Dynamic zero check	0 ± 0.4 ug/m^3	Task 2	Check for leaks through clean filter. Call ME.		30 min	
	Flow audit (at cyclone)	< 10% difference		Advance filter tape twice and check again. Check integrity of pump. Check for obstructions at cyclone, instrument inlet (back of instrument), and nozzle. Call ME or FM and re-calibrate flow meter [1].		30 min	

Task		Performance statistic	Section of SOP or Manual		Frequency	Time	Work-sheet
			Additional task guidance	Additional troubleshooting guidance [1]			
3	**Monthly maintenance**						
	Maintain Aethalometer nozzle	No blockages	Task 3	Check for obstructions and clean	Monthly	15 min	yes
	Maintain inlet cyclone	No blockages	Task 3	Check for obstructions at instrument inlet (back of instrument), and nozzle.		15 min	
	Check vacuum pump filters.	Clean filters	Task 3, Gast Manual	Check integrity of pump.		10 min	
	Change diskette	N/A	Task 3	N/A		5 min	
4	**Bimonthly maintenance**						
	Change filter tape and clean stainless steel supporting mesh	N/A	Task 5, Manual 10, 13.8	N/A	Bimonthly or as needed	15 min	no
	Inspect pump diaphragm and head gasket for cracks or tears	Excessive wear	Task 5, Gast Manual	Replace as necessary. Call ME or FM if the wear is excessive.		30 min	
5	**Re-calibrate flow meter[2] and perform post calibration audit**	< 10% difference	Task 4, Manual 13.5, 14	Advance filter tape twice and check again. Check integrity of pump. Check for obstructions at cyclone, instrument inlet (back of instrument), and nozzle. Call ME or FM and re-calibrate flow meter [2].	As needed	30 min	yes

[1] Key to abbreviations: FM = CRPAQS Field Manager
ME = CRPAQS BAM Measurement Expert

[2] The flowmeter should not be recalibrated without permission from the ME or FM.

SPECIAL NOTE: IF PREFORMING TASKS 2 / 3 OR TASKS 2 / 3 / 4 ON THE SAME DAY, THE FOLLOWING ORDER WILL MAXIMIZE OPERATOR EFFECIENCY AND PROVIDE THE MOST COMPLETE AND ACCURATE RESULTS.

1. **2A – self test**
2. **2B – optical test**
3. **3A – check nozzle**
4. **3C – maintain pump**
5. **3B – instrument cyclone**
6. **4A – change filter tape if necessary**
7. **3D – change diskette**
8. **2A – self test**
9. **2B – optical test**
10. **2C – dynamic zero**
11. **3D – flow audit**

Task 1: Weekly checks

Required materials.

- Quartz-fiber filter tape supplied by Andersen Instruments or Magee Scientific.
- Vinyl gloves for use when handling the quartz filter tape.
- Sharp scissors and packing tape to cut and reconnect the filter tape.
- 1.44 MB high density diskettes to be changed and archived monthly.

Task 1a. Check the percentage of remaining filter tape.

- When the percentage tape remaining is <10 %, or the estimated percentage of tape required for one week of sampling in reached, a new filter tape cartridge should be loaded.
- Follow the instructions listed in Section 10 (Filter Tape Loading) of the manual. A summary of the required operations is also listed in the Task 5 procedures.

Task 1b. Check diskette capacity.

- The front panel will display the remaining disk capacity in terms of days (d) or weeks (w).
- Diskettes should be changed and archived monthly at a minimum. However, the diskette should be changed prior to having 2 days left (2d) regardless of the archiving scheme. Diskettes will be archived at STI.

Task 1c. Check that flow rate is consistent (within 5%) from week to week.

- Advance the filter tape a couple times by pressing the "Advance Tape" switch if the displayed flow rate is significantly different from the previously noted value.
- The external pump and plumbing should be checked if the flow rate deviates by more than 5% from its set value.
- Record any shifts in the displayed flow rates.

Task 1d. Review message files

- The message files (Mfmmddyy.txt) from the diskette should be read and errors noted in the Task 1 worksheet comments section. The message files contain warnings that the Aethalometer has issued in the last week of sampling.

Task 1e. Examine raw data for instrument issues.

The raw data should be examined for possible instrument drift, unrealistic variance in consecutive values, or values outside of expected ranges. The raw data can be examined using the methods listed below. The measurement expert should be contacted if oddities in the data are noted.

- Time series plots of the black carbon concentration and flow using the data acquisition software should be viewed over a 24 hour time frame. Spikes and a small amount of noise in the BC concentration data are to be expected. Section 8 of the manual, Interpretation of the Data, should be read in its entirety.
- BC concentrations above 10 ug/m3 appear to be rare system wide. If the BC concentration exceeds this value then compare the high levels to the OCEC concentrations. Data from the nephelometer and BAM2.5 can also be used to confirm high BC concentrations.
- Negative BC concentrations are not physically possible. Some small negative values are expected due to the nature of the measurement. Negative values should not appear often nor should they last for more than few time bases.
- Oscillations greater than 5 ug/m3 of BC are not expected and require an instrument check.

Task 2: Monthly checks

Required materials:

- Vinyl gloves for use when handling the quartz filter tape.
- Sharp scissors, packing tape, and a stapler to cut and reconnect the filter tape.
- Optical test strip (specific to the instrument).
- Zero-air filter.
- A 2-10 LPM primary flow standard, and external thermometer and barometer for flow audits.

SPECIAL NOTE: IF PREFORMING TASKS 2 / 3 OR TASKS 2 / 3 / 4 ON THE SAME DAY, THE FOLLOWING ORDER WILL MAXIMIZE OPERATOR EFFECIENCY AND PROVIDE THE MOST COMPLETE AND ACCURATE RESULTS .

2A – self test
2B – optical test
3A – check nozzle
3C – maintain pump
3B – instrument cyclone
4A – change filter tape if necessary
3D – change diskette
2A – self test
2B – optical test
2C – dynamic zero
2D – flow audit

Task 2a. The automated self test function (5 minutes)

The automated 'self test' function is outlined in the user manual's Software Operating Instructions section on page 55. This test is used to ensure that the instrument is functioning in accordance with the manufacture's specifications (McGee Scientific, 1998). The self-test runs diagnostic checks on the LED lamp, air flow, user interface panel screen, COM port functionality, and the automatic tape advance mechanisms.

Task 2b. The optical test procedure (15 minutes)

The optical test is outlined in the Manual in the Software Operating Instructions. It is performed to check the operation of the photodetectors. The interpretation and follow up procedures for the optical test results can be found in Section 16.1, Optical Test Strip Algorithm. If the optical test produces a 'balance' or 'ratio' that is outside the acceptable range, contact the Field Manager or Measurement Expect.

Acceptable range of 'balance' = 0.9 to 1.1

Task 2c. A dynamic zero test (30 minutes)

The dynamic zero check is used to check that the instrument is accurately reading a zero BC concentration. Attach the large-area, low-resistance filter on the Aethalometer inlet so that it samples particle free air. The data should fall to 0 ± noise (0.4 ug/m^3) after a few timebase periods (5 minutes).

Task 2d. An audit of the internal mass flow meter at the cyclone (10 minutes)

Methodology:

- Connect a fitted line between the cyclone of the Aethalometer and the outlet of the external flow meter. The flow read from a volumetric flow meter needs to be corrected for standard conditions.

  STP for the Aethalometer is 293K and 1017 mb.

- Compare the instrument flow readings with the volumetric flow meter attached to that of the external flow meter adjusted to standard conditions. The difference should be less than 10 percent.
- If the percent difference exceeds 10 percent, advance the filter tape once or twice by holding the "Advance Tape" switch down for about 30 seconds. Re-audit the flow meter with the new filter tape position.
- If the percent difference is greater than 10 %, contact the Measurement Expert or Field Manager. Re-calibration procedures are described in Task 5.

Typical flow problems:

- If the flow is less than 6.9 LPM: Check the line to the pump for obstructions or crimps. If there are no obstructions at this point, check the pump (diaphragm).
- If the flows deviate more than ± 0.7 LPM from the last setpoint (which should have been 6.9 LPM): Check and reapply the grease on the inlet at the cyclone. Retighten the adapter that joins the 2 extension pieces together.

Flow audit procedures:

Fill out the worksheet each time a flow audit is performed and archive the worksheet. The flow should be audited while the instrument is normally sampling.

a: Record the primary flow standard serial number and make.

b: Record the current ambient conditions

Record the current temperature and pressure using an external thermometer and barometer by placing both in a shaded area. Convert the measurements to K and mb.

T (K) = T (C) + 273.15
P (mb) = P (inHg) x 33.87 = P (mmHg) x 1.33

c: Calculate the Ratio of STP to ambient conditions

Use the STP conditions for the Aethalometer mass flow meter to determine the ratio between STP and the current temperature and pressure. STP for the Andersen Instruments Aethalometer is 293K and 1017 mb.

Ratio of STP to ambient conditions = 293.15K x P (mb) / T (K) / 1017 (mb)

d: Record the time when the audit was started

e: Record several instrument flowrates (as seen on the instrument display)

Flow with cyclone – Record the instrument flow before attaching the BIOS.

Flow with BIOS attached – Remove the cyclone rain-hat and attach a tight-fitting BIOS hose to the cyclone inlet. Place the BIOS on a horizontal surface level with the top of the inlet, making sure that the BIOS hose does not crimp. You can use a ladder. Record the instrument flow after this has been done.

f: Record several BIOS flowrates (as seen on the BIOS display)

Adjust the valve on the audit adapter to allow air to flow to the instrument. Press and hold the STOP/RESET key on the BIOS until the BIOS screen shows:

```
Flow> L                OFF
Average>      L        #
        Number in Average   ^
```

Press and hold the READ/AUTO key on the BIOS until you can hear the flow cell moving up and down. Allow the BIOS to count through several 1-10 sequences. When value3 reaches "10" again, write down value2 on the flow audit worksheet, where value1 is the current flow rate (LPM), value2 is the current average flow rate (LPM), and value3 is the current measurement number (out of 10) used to calculate value2.

```
Flow>          value1
Average>       value2     value3
        Number in Average   ^
```

Repeat this for 9 more cycles and fill out the worksheet. Reset the BIOS. Remove the cyclone and check the cyclone o-rings for cracking and wear. Replace as needed. Apply a new thin layer of high vacuum grease to the cyclone orings, and reattach the cyclone.

g: Record the time when the instrument was returned online.

h: Compare Aethalometer to BIOS

Average BIOS flow = Sum of the 10 BIOS readings / 10
Average adjusted BIOS flow = Average BIOS flow x Ratio of STP to ambient
Delta = Average adjusted BIOS flow - Instrument flow with BIOS attached
% Difference = (Delta / Average adjusted BIOS flow) x 100

i: Compare Aethalometer to Setpoint

Flow rate setpoint for Aethalometers = 6.9 LPM
Current Aethalometer flow rate = Instrument flow (Task 5e)
Aethalometer flow rate ± 1.0 LPM of setpoint =
Flow rate setpoint - Current Aethalometer flow rate

j: A percent difference greater than 10 % warrants re-calibration of the flow meter; see section 14.4 of this SOP.

k: Comments

NOTE: If the percent difference exceeds 10 percent advance the filter tape once or twice by holding the "Advance Tape" switch down for about 30 seconds. Re-audit the flow meter at the new filter tape position.

Update the logs:

- Site log – Record the offline and online time.
  Note in the comment section that a flow audit was being performed.
- Instrument log – Record the offline and online time and note a flow audit.

Task 3: Monthly maintenance

Required materials.

- Cleaning items such as cotton-tipped swabs, paper towels, and cloth towels, ethanol, and water.
- 1.44 MB high density diskettes to be changed and archived monthly.

Task 3a. Check nozzle.

- Look for blockage by debris and/or insects. The sampling spots will look misshapen or "fuzzy" around the edges if there is an obstruction.
- Power down the Aethalometer. Remove the nozzle by removing the top panel of the instrument. Unscrew the top from the optical chamber. Disconnect the cable from the optical chamber and pull the top aside. Gently pull the optical chamber while holding onto the black rubber inlet tubing (on the other side of the divider.)
- Clean the metal parts with ethanol and a cotton-tipped swab. Do not use a blade to clean the nozzle. Clean the plastic parts with water and a cotton-tipped swab.
- Reconnect the optical chamber, cable, and cap. Be careful to not dislodge the ring above the nozzle. Perform a Self Test and Optical test to check that the instrument is reconnected properly.

Task 3b. Maintain the instrument cyclone.

The Andersen Aethalometer uses a $PM_{2.5}$ cyclone mated to the inlet tubing using an adapter. Perform the tasks listed below to maintain the cyclone.

- Remove the cyclone from the adapter. Clean the adapter using ethanol and kimwipes/swabs.
- Disassemble the cyclone as indicated in Task Figure 1. The o-rings do not need to be removed. The $PM_{2.5}$ cyclone is composed of two stainless steel sections and a stainless steel grit pot. Wipe dust, grit, and / or water from the all sections with a clean towel.
- Check that the o-rings are not dry, brittle, or cracked. If they are simply dry, place a thin layer of high vacuum grease over them before reassembling the system. O-rings that appear brittle or cracked require replacement.
- Reassemble the cyclone and reattach it to the sampling line.

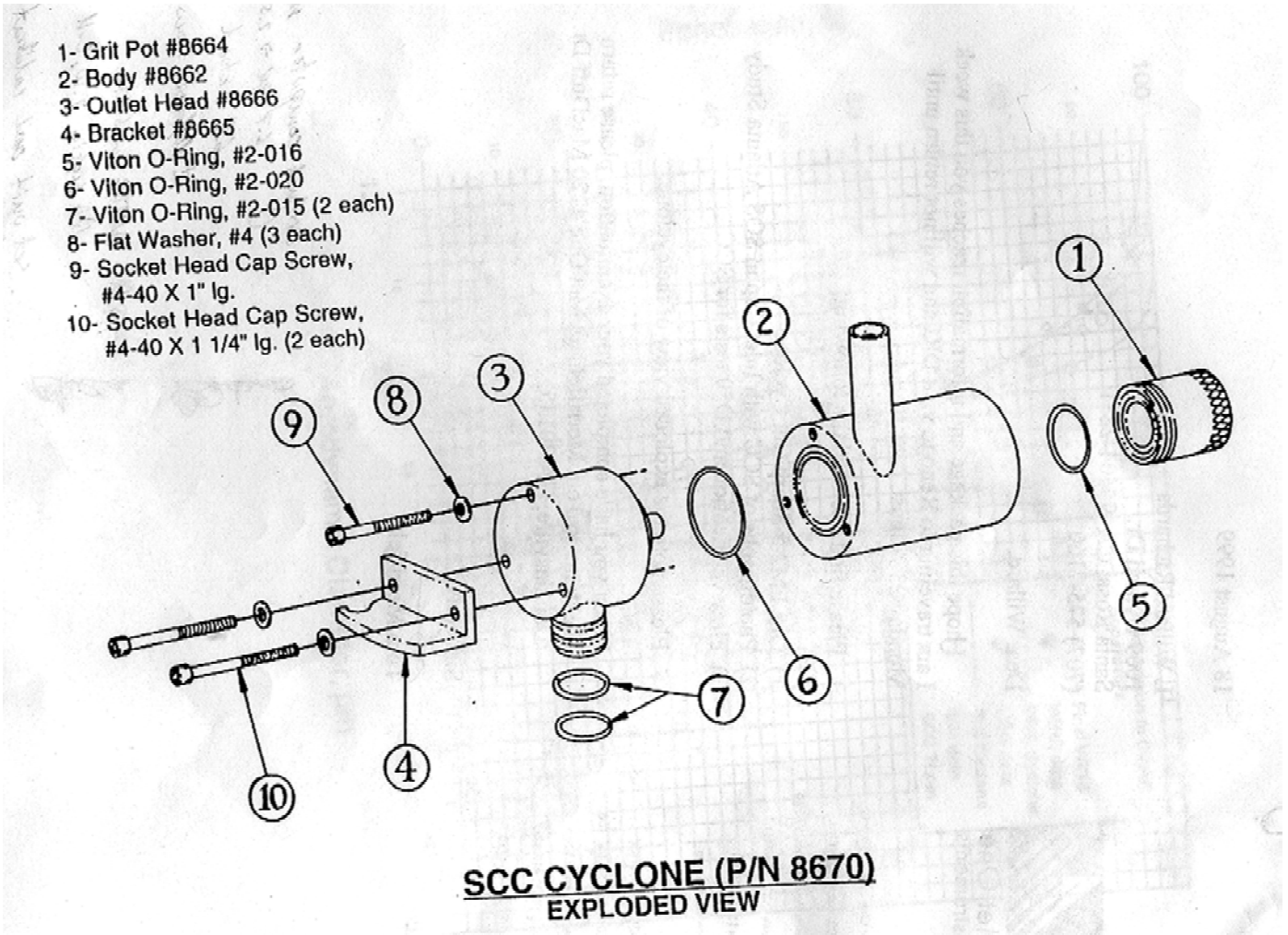
Task 3c. Maintain the vacuum pump.

- Check the vacuum pump filters for build up. Wash with water if necessary, and let dry thoroughly prior to re-assembly of the pump. Replace torn, brittle, or otherwise damaged filters.
- Check the head gasket and diaphragm for excessive wear. Replace these components if they are torn or brittle. Consult GAST for more information.

Task 3d. Change the data diskette.

The instrument will be running during this period and will be attempting to write data to the diskette every five minutes.

- Change the diskette as quickly as possible within the first two minutes of a measurement cycle (Remove the disk when the disk drive light turns off.)
- Label the diskettes with the instrument serial number, the month and year of data, the date of removal, and the site operator's name.



Task Figure 1. Manufacture's schematic of sharp cut cyclone.

Task 4: Bimonthly maintenance

Required materials.

- Quartz-fiber filter tape supplied by Andersen Instruments or Magee Scientific.
- Vinyl gloves for use when handling the quartz filter tape.
- Sharp scissors and packing tape to cut and reconnect the filter tape.

Task 4a. Replacement of the filter tape.

A summary of the steps listed in the manual (Manual Section 10, Filter Tape Loading) is provided below for convenience. Please note that the information listed below is only intended to supplement the steps outlined by the manual.

- Stop measurements and go into the "Install new tape" menu. This function must be used to retain accuracy in the percentage of filter tape remaining.
- Disconnect the pump.
- Remove the analyzer chamber cover plate (also called the optical shield).
- Use scissors to cut the filter tape at the supply side (left hand side of optical sensing region). Leave ~1 inch of tape hanging out the optical sensing region.
- Remove the old roll of tape from the supply side and replace it with the new roll of quartz fiber filter tape.
- Use strong adhesive tape (packing or duct tape) to connect the new filter tape to the old tape. The old tape should still be sticking out of the optical sensing region.
- Press the tape advance button to raise the optical source chamber (inlet assembly). Once the chamber is not clamping down on the filter tape, pull the old tape out to the right. Pull ~ 20 cm of new tape through the optical sensing region. Cut off the old tape.
- Remove the filled spool of used tape from the right hand (take-up) side, discard it, but retain the cardboard center. Be sure not to dislodge the o-ring behind the spool cardboard center.
- Put the new cardboard center (from the replacement tape box) onto the take-up hub. Take ~10 cm. of the new tape and clamp it onto the cardboard center using the metallic spring clip.
- Turn the take-up reel counter-clockwise to roll up any slack in the filter tape.
- Be sure that the cardboard center is pushed against the o-ring behind it. The o-ring supplies friction against the cardboard center to pull the filter tape.
- Replace the clear flanges on the supply and take-up spools. Tighten thumb screws to finger tight. Pull on the supply tape on the left to check that the supply roll can turn.

- Manually lift the optical chamber and move filter tape out of the analyzing region. Clean the stainless steel supporting mesh using a clean cotton-tipped swab soaked in ethanol. Re-position the filter tape in the analyzing region.
- Press the "Tape Tension" switch to roll up any slack tape on the right side.
- Replace the analyzer chamber cover plate and its two thumb screws.
- Connect the pump and put the instrument back into operation mode. Watch the first few filter tape advances upon startup to make sure the system is functioning properly.

Task 4b: Pump maintenance.

Replace the vacuum pump diaphragm and/or head gasket when required (i.e. if cracked or brittle). The diaphragm and head gasket should be inspected for cracks or tears on a bimonthly basis. See the GAST manual for more information.

Task 5: Recalibrate flow meter

Required materials.

- A 2-10 LPM primary flow standard, and external thermometer and barometer for flow audits.

  A low-impedance primary flow standard (with adjustment of flows for ambient conditions) should be used to audit the flows on the aethalometer. The flow standard flowrates should be adjusted from ambient conditions to STP before comparing the instrument flowrates to the flow standard flowrates. The internal mass flow meter in the Andersen Instruments Aethalometer is calibrated at STP (293.15K and 1017 mb). Therefore flow standard flowrates should be adjusted as shown below.

  Ratio of STP to ambient conditions (Ratio) = 293.15 x P (mb) / 1017 / T(K)
  Adjusted flow standard flow rate = Average flow standard flow rate x Ratio

  The reported flow (on the Aethalometer screen) during normal operation should be 6.9 LPM ± 5%. A manual audit if this flow can be performed while the instrument is sampling. If the flow during normal operation within this range, the instrument is considered to be working properly.

  If the flows deviate from this range, it is likely that there is an obstruction or leak. These possibilities should be investigated fully before re-calibrating the flow meter. A re-calibration is only to be performed when the site operator is convinced that the internal mass flow meter is operating outside of a 10 % difference from the instrument reading when using a low-impedance primary flow standard (with adjustment of flows for ambient conditions).

The instrument flow meter should only be re-calibrated when authorized by the Field Manager or Measurement Expert. The flow meter re-calibration should be performed at the instrument inlet and audited at the both the instrument inlet and at the cyclone so that leakage in the sampling line can be investigated, prior to setting the instrument back online. The flow through the instrument (using the flow regulator at the back of the instrument) should be set so that 6.9 LPM is measured at the instrument inlet by the external flow meter. Follow the procedure for re-calibrating the flow meter (Manual Sections 13.5, Calibrate Flow Meter, and 14, Flow meter Response Re-Calibration). Before re-calibrating the flow meter, perform the following checks to verify that the flow meter needs re-calibration and then contact the Field Manager or Measurement Expert. **Note.** Any repairs to the instrument should be performed by Andersen Instruments or Magee Scientific.

Task 5a. Checks to verify flow meter needs re-calibration.

- Note in the site log that the instrument was taken offline.
- Record the flow meter and instrument serial numbers, and the ambient temperature and pressure on the worksheet. Record all system changes and resulting flow rates in the instrument log.

- Attach the external flow meter to the inlet line (remove the rain cap first). Record the initial flow rate at the inlet before trying to identify the cause of the problem.
- Audit the flow at the instrument cyclone. If the flow is still ± 10% of 6.9 LPM, check that the cyclone is free of obstructions and that o-rings are not dry, brittle, or cracked. Check that the cyclone grit pot does not require cleaning. Replace the o-rings and apply a thin layer of high vacuum grease to them before reinserting the cyclone into the inlet adapter. Re-audit the flows at the cyclone.
- If the flow is still ± 10% of 6.9 LPM, then re-audit the flow at the instrument inlet using a short piece of inlet tubing. If the flow is ± 10% of 6.9 LPM, there is likely to be an obstruction in the line or a problem with the filter tape.
  - Advance the filter tape and re-audit the flow.
  - Advance the filter tape and re-audit the flow again.
  - Check the integrity of the pump. Re-audit the flow if anything is modified.
  - Check for obstructions at the cyclone, instrument inlet (back of instrument), and nozzle. If modifications are made, re-audit the flow again.
- When the instrument flow is ± 10% of 6.9 LPM, perform a final audit of the flow at the instrument inlet using a short piece of inlet tubing.
- Perform a final audit the flow at the instrument cyclone.

Typical flow problems.

- Check the line to the pump for obstructions or crimps. If there are no obstructions at this point, check the pump (diaphragm).
- Check for obstructions at the cyclone, instrument inlet (at the back of the instrument), and at the nozzle. Remove deposits from all non-metal surfaces using water and cotton swab/paper towel - do not use a blade.

Contact information:

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Instrument:	Anderson Instruments Aethalometer
Worksheet:	Task 1 - Weekly checks (weekly)
Site Code:	

Date	/ /	/ /	/ /	/ /	/ /
Field Tech					
Instrument SN					
INITIAL CHECKS:					
Time					
DAS clock (PST)	: :	: :	: :	: :	: :
Aethalometer clock (PST)	: :	: :	: :	: :	: :
Aethalometer statistics					
Filter remaining (%)					
Disk remaining (wk, d, or h)					
Current BC value (ug/m^3)					
1.) WEEKLY CHECKS:					
Check filter tape					
Tears?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Overlapping or oddly shaped samples?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Proper spooling of filter tape?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Check instrument					
Visibly dirty?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Check flowrate on instrument panel					
Flowrate (LPM)					
6.9 +/- 1 (LPM)?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Compare flowrate with last flowrate check					
Date of last flowrate check	/ /	/ /	/ /	/ /	/ /
Difference since last check (LPM)					
Error messages					
Date of last error review	/ /	/ /	/ /	/ /	/ /
Reviewed all prior messages?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Errors or warnings?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Comments -List all errors or warnings by date, time, and type.					

Instrument:	Anderson Instruments Aethalometer
Worksheet:	Task 2 - Monthly checks (monthly) - Not including flow audit worksheet Task 3 - Monthly maintenance (monthly)
Site Code:	

Date		/ /	/ /	/ /
Field Tech				
Instrument SN				
INITIAL CHECKS:				
Time				
DAS clock (PST)		: :	: :	: :
Aethalometer clock (PST)		: :	: :	: :
Aethalometer statistics				
Filter remaining (%)				
Disk remaining (wk, d, or h)				
Current BC value (ug/m^3)				
2.) MONTHLY CHECKS:				
Parameter	Acceptable range			
Self-test pass?	All tests pass	Yes / No	Yes / No	Yes / No
Lamp test pass?	Pass	Yes / No	Yes / No	Yes / No
Pump bypass test pass?	Pass	Yes / No	Yes / No	Yes / No
All LEDs functioning?	Pass	Yes / No	Yes / No	Yes / No
Filter tape advancing?	Pass	Yes / No	Yes / No	Yes / No
Optical test strip pass?	0.9 - 1.1 (redo if fail)	Yes / No	Yes / No	Yes / No
1st test pass? / Balance	0.9 - 1.1	Yes / No /	Yes / No /	Yes / No /
2nd test pass? / Balance	0.9 - 1.1	Yes / No /	Yes / No /	Yes / No /
Dynamic zero pass?	-0.4 - 0.4	Yes / No	Yes / No	Yes / No
Test start time (PST)	N/A	: :	: :	: :
Test end time (PST)	N/A	: :	: :	: :
Resulting value (ug/m^3)	-0.4 - 0.4			
Flow audit pass?				
1st test pass? / %	< 10% difference	Yes / No /	Yes / No /	Yes / No /
2nd test pass? / %	< 10% difference	Yes / No /	Yes / No /	Yes / No /
Comments				
3.) MONTHLY MAINTENANCE:				
Check inlet at cyclone				
Any blockage?		Yes / No	Yes / No	Yes / No
Check vacuum pump filters				
Filters replaced?		Yes / No	Yes / No	Yes / No
Head gasket okay?		Yes / No	Yes / No	Yes / No
Diaphragm okay?		Yes / No	Yes / No	Yes / No
Comments				

Instrument:	Anderson Instruments Aethalometer
Worksheet:	Task 2 - Monthly checks (monthly) - Flow audit section Task 3 - Monthly maintenance (monthly)
Site Code:	

Date	/ /	/ /	/ /
Field Tech			
Instrument SN			
PERFORM FLOW AUDIT:			
Flow audit formula			
T (K) = T (C) + 273.15			
P (mb) = P (in Hg) x 33.87 = P (mm Hg) x 1.33			
Ratio of STP to ambient conditions = 293.15 x P (mb) / 1017 / T (K)			
Adjusted average BIOS flow (LPM) = Average BIOS flow (LPM) x Ratio of STP to ambient conditions			
Delta (LPM) = Adjusted average BIOS flow (LPM) - Instrument flowrate with BIOS attached (LPM)			
% Difference (%) = 100 x Delta (LPM) / Adjusted average BIOS flow (LPM)			
a.) BIOS model / SN	40DCL /	40DCL /	40DCL /
b.) Ambient conditions			
Temperature (C) / Temperature (K)	/	/	/
Pressure (in Hg or mm Hg) / Pressure (mb)	/	/	/
c.) Ratio of STP to ambient conditions			
d.) Start date (PST) / Time	/	/	/
e.) Instrument flowrates (LPM)			
Flow without BIOS attached (LPM)			
Flow with BIOS attached (LPM)			
f.) BIOS flowrates (LPM) / Time			
1st BIOS flow (LPM) / Time	/	/	/
2nd BIOS flow (LPM) / Time	/	/	/
3rd BIOS flow (LPM) / Time	/	/	/
4th BIOS flow (LPM) / Time	/	/	/
5th BIOS flow (LPM) / Time	/	/	/
6th BIOS flow (LPM) / Time	/	/	/
7th BIOS flow (LPM) / Time	/	/	/
8th BIOS flow (LPM) / Time	/	/	/
9th BIOS flow (LPM) / Time	/	/	/
10th BIOS flow (LPM) / Time	/	/	/
g.) Stop date (PST) / Time	/	/	/
h.) Compare Aethalometer to BIOS			
Average BIOS flow (LPM)			
Adjusted average BIOS flow (LPM)			
Delta (LPM)			
% Difference (%)			
i.) Compare Aethalometer to Setpoint			
Flowrate setpoint for aethalometer	6.9 LPM	6.9 LPM	6.9 LPM
Current aethalometer flowrate (LPM)			
Aethalometer flowrate ±1 LPM of setpoint?	Yes / No	Yes / No	Yes / No
Aethalometer flowrate adjusted?	Yes / No	Yes / No	Yes / No
New Aethalometer flowrate (LPM)			
Date (PST) / Time flowrate adjusted	/	/	/
j.) Comments			

Instrument:	Anderson Instruments Aethalometer
Worksheet:	Task 5 - Re-calibrate flowmeter (as needed) *NEED PERMISSION
Site Code:	

Date	/ /	/ /	/ /
Field Tech			
Instrument SN			
INITIAL CHECKS:			
Time			
DAS clock (PST)	: :	: :	: :
Aethalometer clock (PST)	: :	: :	: :
Aethalometer statistics			
Filter remaining (%)			
Disk remaining			
Current BC value (ug/m^3)			
5.) RECALIBRATE FLOWMETER:			
Reason for realibrating flowmeter			
BIOS model / SN	40DCL /	40DCL /	40DCL /
1st audit done at cyclone			
Instrument flow with BIOS attached (LPM)			
Adjusted average BIOS flow at cyclone (LPM)			
% difference			
Comments			
2nd audit done at cyclone			
Instrument flow with BIOS attached (LPM)			
Adjusted average BIOS flow at cyclone (LPM)			
% difference			
Comments			
1st audit done at instrument back			
Instrument flow with BIOS attached (LPM)			
Adjusted average BIOS flow at instrument (LPM)			
% difference			
Comments			
Calibrate flowmeter			
Flowmeter zero (voltage or LPM)			
Flowmeter air flow (LPM)			
Flow scale factor			
Set instrument flow to adjusted BIOS flow (LPM)	Yes / No	Yes / No	Yes / No
New flowmeter air flow (LPM)			
New flow scale factor			
Adjusted average BIOS flow at instrument (LPM)			
Instrument adjusted (6.9 LPM w/o BIOS attached)	Yes / No	Yes / No	Yes / No
Date (PST) / Time flowrate adjusted	/	/	/
Comments			
Post calibration flow audits			
2nd audit done at instrument back			
Instrument flow with BIOS attached (LPM)			
Adjusted average BIOS flow at instrument (LPM)			
% difference			
Comments			
3rd audit done at cyclone			
Instrument flow with BIOS attached (LPM)			
Adjusted average BIOS flow at cyclone (LPM)			
% difference			
Comments			
Instrument setpoint (LPM)	6.9 LPM	6.9 LPM	6.9 LPM
Instrument reading (LPM)			